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BREEDING FOR RESISTANCE TO LATE BLIGHT IN THE POTATO

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The economic importance of late blight of potato caused by *Phytophthora infestans* (Mont.) de Bary, has been discussed so frequently that further discussion seems unnecessary. Control measures are being practiced more generally than ever, spray equipment has been improved and spray programs have been more faithfully carried out but, despite these practices, large losses continue to occur as the result of the attacks of this disease. The estimated reductions in yields of potatoes caused by late blight which occurred during the ten-year period, 1926-1935 inclusive, are given in table 1. The data are taken from *The Plant Disease Reporter* issued by the Division of Mycology and Disease Survey.

The estimates show a reduction in yields for the country as a whole of approximately 31 million bushels in the blight year of 1928 with an average for the ten-year period of over nine and one-half million. In some years the losses are comparatively slight and even in blight years they are not uniform for all potato growing states. They are large enough in any single year, however, to justify increased efforts to eliminate the disease by still more efficient methods of control and by the production of blight-resistant varieties.

Breeding for resistance to late blight was begun at a comparatively early date. According to K. O. Müller (4), Darwin, as early as 1870, attempted through the use of species hybrids to produce potato varieties resistant to *Phytophthora*, but he evidently was not successful. Certain progeny of crosses, one of the parents of which was a wild

TABLE I.—*Estimated reduction in yield of potatoes due to late blight for the ten-year period, 1926-1935 inclusive. Reductions are expressed in thousands of bushels*

Name of State	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935*	Total
Maine	12,655	4,602	1,148	4,628	3,836	9,058	939	662			37,528
N. H.		112				17					129
Mass.	712	972			301	36	179	153			2,353
Conn.	32	52				10	22				116
N. Y.	2,901	11,115	12,950						1,366	1,150	29,482
N. J.			98								98
Pa.	5,100		3,411					154	938		9,603
Ohio	502										502
Mich.			884								884
Wisc.	3,528	131	1,757								5,416
Minn.	414		3,886								4,300
Iowa			129								129
Del.		83									83
Md.	110	330	275	96	33	81	52	72	56		1,105
Va.		215									215
W. Va.			893								893
N. C.	74	140	260	216							690
S. C.				266							266
Ga.		13	22		16						51
Fla.	283			27	492	44	34	438	234		1,552
Tenn.			747								747
Tex.						168	23	4			195
Oreg.		409									409
Totals	12,530	26,269	30,998	1,753	5,169	4,430	9,230	1,808	3,409	1,150	96,746

*Reports not yet completed for 1935.

immune plant (the origin of which according to Reddick and Cressier (6) is not known), the so-called W-race, were found by Müller to be immune to one of the physiological forms of *Phytophthora*. Genetic analyses of this material brought out some interesting points. The types of segregation shown in certain F_2 progenies indicated the presence of at least two pairs of genes for resistance. It was shown, too, that the resistance found in these crosses in the field was not a result of a natural tendency to later ripening as has been commonly supposed. Resistance was not closely linked with any of the other commercially important characters. In a later paper Müller (5) discusses biologic specialization in *Phytophthora infestans*, and its relation to breeding for resistance to late blight. Five strains, three A and two S types, of the biologic forms of *P. infestans*, were tested on tubers of three hundred and sixty standard varieties of potatoes (German and foreign) on Broili's Ef strain, and on species of *Solanum demissum* and their hybrids with cultivated types. All the commercial varieties proved more or less susceptible to both A and S types, with one exception—a cross between a W-race and a cultivated variety). Some of the A types attacked the tubers of the semi-resistant W_2 and W_3 groups with varying degrees of severity, but in all cases they caused little or no damage to the highly resistant W_1 group. None of the W forms was resistant to the S types of *P. infestans*. *S. demissum* and its F_1 hybrids with cultivated varieties showed a high degree of resistance to both the A and S types. Müller concludes that since the W forms of potatoes are susceptible to the S types of *P. infestans* they cannot be used to solve the late blight problem. He states that there are possibilities, however, in the hybrids between *S. demissum* and the cultivated potato and perhaps also in other lines of approach requiring further investigation.

According to Stuart, (7) Chauncey Goodrich of Utica, New York, was perhaps the first American breeder to conceive the idea of eradicating the late blight disease by the introduction and production of new varieties. In 1851 he received a small quantity of South American potatoes through the American consul at Panama. Although he did not succeed in introducing or producing blight-resistant sorts, the varieties with which he worked have played an important part in potato production and improvement. A number of other breeders made valuable contributions during the latter part of the 19th century but with the exception of the work of Goodrich, resistance to late blight seems not to have been emphasized again until potato breeding was actively undertaken by the United States Department of Agriculture

in 1910. According to Clark et al, (3) the only disease resistance sought, at that time, was from the late blight fungus. This work had not progressed very far, however, when it became evident that the virus diseases had to be given the chief consideration and it was not until the present national potato breeding program was initiated that emphasis could be placed once more on breeding for resistance to late blight.

Bukasov, (2) in a recent interesting paper prepared for the 1935 meetings of the Potato Association of America, on "The Problems of Plant Breeding", states that in recent years extensive work has been done on *S. demissum* at the Institute of Plant Breeding, Munchenburg, Germany, by E. Schmidt, a plant breeder with the Kamecke firm, by Salaman in England, by the Corstorphine Station in Scotland and by a number of other institutions. The work of E. Schmidt shows a continued loss of the resistance of *S. demissum* with three successive back crosses to *S. tuberosum*. This was true for both the common and the S races of *Phytophthora*. Salaman, in a letter to Bukasov, stated that his hybrids of *S. demissum* have been carried to the tenth generation and that the results are full of promise. In these hybrids not only the vine but the tubers are resistant. Salaman works with crosses other than repeated back-crosses as practiced by American, German and Soviet plant breeders. Salaman is quoted as saying, "We have founded a solid basis for the creation of really resistant varieties".

Reddick and Crosier (6) discuss the importance of biological specialization in *Phytophthora infestans* and its relation to breeding for resistance to late blight. It is pointed out that some tests have been made at Ithaca but that no systematic and comprehensive series of tests with all the different samples of the fungus and a uniform series of potato varieties have been made. They state, "Several Mexican species are being used extensively in a breeding program for the development of blight resistant or immune domestic varieties in the United States as well as in other countries and it becomes a matter of concern to determine as soon as possible whether biotypes exist in North America". Reddick, working in cooperation with the United States Department of Agriculture, is using species hybrids for the purpose of developing resistant varieties and is making real progress.

The work of the U. S. Department of Agriculture in cooperation with the University of Maine at Presque Isle, Maine, and at Beltsville and Oakland, Maryland, in cooperation with the University of Maryland, is an attempt to see what progress can be made with varieties and strains of *S. tuberosum* without the use of species hybrids.

It has long been known that varieties of cultivated potatoes show various degrees of susceptibility. Varieties have been brought into this country from time to time which were distinctly more resistant than the sorts commonly grown but which, because of their extreme lateness, poor quality or other undesirable characters, never were distributed to any extent. One of the most promising of these for Maine conditions, known as Foster's Rust Proof or No Blight, has been described by Bonde (1). In spite of the fact that this variety still continues to be only slightly injured by blight even, in years of severe epidemics, it is not being grown very extensively.

The blight epidemic of 1932, which caused an estimated loss of nine million bushels in Maine alone (table 1) brought up the problem again with added force. In that year approximately seven hundred seedlings representing four different progenies and about one hundred Green Mountain checks were grown at Presque Isle, Maine, in rows of twenty to thirty hills each. This plot, of about one and one-half acres in area, was not sprayed with Bordeaux but was sprayed in July with a single application of calcium arsenate, to kill the Colorado potato beetle. Late blight infection was first observed on July 22. Conditions favorable for the spread of the disease prevailed during August so that by the first week in September nearly all the seedlings and all the Green Mountain checks were completely killed, both leaves and stems. A few seedlings showed the stems and about one-fifth of the leaves remaining free from blight infection whereas a still smaller group manifested only a few infected leaves. There were no immune seedlings. A number of the most resistant lines were from naturally fertilized progeny of Katahdin. A few seedlings, too, of the cross Chippewa x Katahdin escaped with very little injury. From this test it was evident that there are different degrees of resistance; that resistant varieties can be obtained by inbreeding certain susceptible varieties and by crossing two susceptibles. The test also demonstrated too that a variety, even if not immune, but resistant enough to go unsprayed through one of the worst epidemics which has occurred in Maine for some time, might be extremely valuable to the growers. It showed also that lateness is not completely correlated with blight resistance since all the seedlings were comparatively late but hundreds of them were killed by blight before they had time to mature.

The 1933 blight tests at Presque Isle were a failure because so little late blight developed that the susceptible Green Mountain checks were uninjured. It was evident from this test that natural epidemics could not be depended upon in the blight resistance work and as a re-

sult epidemics have since then been induced artificially by spraying the plants with spores of the blight fungus.

In the spring of 1934 six hundred and eighty seedlings two hills to each seedling lot were tested for blight resistance in the greenhouse at Arlington. Table 2 gives the data for this test.

TABLE 2.—*Late blight test in the greenhouse at Arlington Farm, Virginia in the spring of 1934*

Progeny Number	Parentage	Seedlings showing degrees of late blight resistance				
		¹ N-	N		G	Total
			No.	No.		
	Miscellaneous seedlings	1	7		112	120
336	No Blight X Katahdin	11	152	212	92	467
1241	Katahdin selfed		10	41	42	93
	No Blight check		22			22
	Green Mountain check				38	38
	Ackersegen check	7	11	3		21
	Ekishirazu check	2				2

¹N- =More resistant than No Blight.

N =As resistant as No Blight (only a few spots on the leaves).

N+ =More susceptible than No Blight, but less heavily infected than Green Mountain.

G =As susceptible as Green Mountain (ranging from $\frac{1}{4}$ of leaves infected to many leaves killed and stems badly injured).

Green Mountain, No Blight, Ackersegen and Ekishirazu were grown as checks. There was some variation in the reaction of each of these controls to the disease but in every case No Blight was resistant and Green Mountain was susceptible. No Blight had only a few spots on the leaves, but the Green Mountain had many leaves killed and the stems were badly injured by late blight. Of the one hundred and twenty selections from various progenies one contracted less late blight than No Blight, seven were judged as resistant as No Blight and one hundred and twelve were as susceptible as Green Mountain. The progeny of the cross No Blight x Katahdin showed a wide range

of variation. Of the four hundred and sixty-seven seedlings of this cross, eleven were less blighted than the resistant parent, No Blight; one hundred and fifty-two were like No Blight; two hundred and twelve were intermediate between No Blight and Green Mountain and ninety-two were as susceptible as Green Mountain. Askersegen, a yellow-fleshed variety introduced from Germany and reported to be resistant to potato wart, late blight and common scab, was found to be about as resistant to late blight as No Blight. Ekishirazu, an introduction from Japan, showed less late blight than No Blight.

In the field tests at Presque Isle, Maine, the same year ten hills from each lot were exposed to infection. The Green Mountain variety served as a susceptible control and No Blight as a resistant control. These controls were replicated throughout the plot, as were also the parents among their respective progenies.

During the first week in August, when many of the plants were in blossom, the potato tops were sprayed with a spore suspension of the late blight fungus. Infected potato foliage served as the source of the late blight spores.

The field tests at Presque Isle, Maine, were more satisfactory in 1934 than they were the preceding year.

Table 3 gives the data for the 1934 blight resistance test grown in the field at Presque Isle.

Many of the leaves of the Green Mountain checks were dead and the stems injured by the blight on August 25. No Blight continued to show resistance,—only twenty to forty leaflets on each hill showed blight, none of the leaflets being killed. A number of the progeny of the No Blight x Ekishirazu, two blight-resistant varieties, were highly resistant to blight. Of the one hundred and fifty grown, twenty-five were free from blight, one hundred and fourteen showed as much blight as the No Blight parent and eleven of them were more heavily infected than either parent, but all of them were more resistant than Green Mountain. Three hundred and forty seedlings of the No Blight X Katahdin cross showed about the same variation as was obtained for this same cross in the greenhouse tests. The progenies related to the so-called W-races, the seed of which was kindly sent to us by K. O. Müller, Berlin-Dahlem, Germany, showed marked degrees of resistance. A comparatively large number of them did not contract late blight while the Green Mountain checks in close proximity were heavily infected.

Three progenies including two hills from each seedling lot, the

TABLE 3.—*Late blight test in the field at Presque Isle, Maine, in 1934*

Progeny Number	Parentage	Seedlings Showing Degrees of Resistance to Late Blight							
		'O	N-	N	N+	G-	G	G+	Total
		No.	No.	No.	No.	No.	No.	No.	No.
182	No Blight X Ekishirazu	25		114	5	6			150
336	No Blight X Katahdin		7	26	177	75	50	5	340
3,730	Progeny of German races	4	1	1	3				9
3,738	" "	52	5	5	14	5	1		82
3,743	" "	4	2	12	4				22
3,744	" "	16	4	7	7	4			38
3,747	" "	14					1		15
3,868	" "			3	3	5	2	1	14
3,895	" "	12	1					1	14
3,897	" "	58	3	3	6	7	11	1	89
4,035	" "	1					2	1	4
4,050	" "	10	10	6	3	5	3	2	39
4,054	" "	5	8					1	14
Green Mountain Check							35		35
No Blight Check				21					21
Ekishirazu Check		19	2						21

'O =No infection.

N- =More resistant than No Blight.

N =As resistant as No Blight (only a few spots on the leaves).

N+ =More susceptible than No Blight but less than $\frac{1}{4}$ of leaves infected.G- = $\frac{1}{4}$ to $\frac{1}{3}$ leaves infected.G =Approximately $\frac{1}{2}$ of leaves infected (as found in the average Green Mountain plot).G+ =More than $\frac{1}{2}$ of leaves infected; many leaves dead and stems badly injured.

parents and Green Mountain checks were tested in the greenhouse at Beltsville in 1935. The data for this test are given in table 4.

TABLE 4.—*Late blight test in the greenhouse at Beltsville, Maryland, in 1935*

Progeny No.	Cross or Variety	Seedlings Showing Degrees of Late Blight Resistance								
		'O No.	N- No.	N No.	N+ No.	G- No.	G No.	G+ No.	Total No.	
618	S45349 X Ekishirazu	91	213	156	24	7	1	492		
627	No Blight X S45075		32	93	125	162	45	457		
672	Ackersegen X Katahdin		6	31	9	51	2	99		
	Green Mountain check			1	2	19	22	44		
	Katahdin			3	6	2		11		
	S45075				1	6	3	10		
	No Blight	2	24	12				38		
	Ackersegen	1	25	19			.	45		
	S45349		2	1				3		
	Ekishirazu	2						2		

¹See table 3 for description of classes.

The cross between two resistant varieties S45349 x Ekishirazu showed a higher degree of resistance than the two crosses which had only one resistant parent in each case. The Green Mountain, Katahdin and S45075 were again heavily infected and the No Blight and Ackersegen were in the same classes as in the 1934 test.

The most promising seedlings which were considered resistant in 1934 were tested again in the field in 1935. The plots, planted as in 1934, were sprayed with a water suspension of blight spores several times during the growing season and although the conditions were not entirely favorable, a satisfactory epidemic developed. Table 5 gives the data for the field tests at Presque Isle in 1935.

Of the one hundred and fifty-one seedlings of the crosses No Blight x Ekishirazu, No Blight x Katahdin and the German progenies,

TABLE 5.—*Late blight test in the field at Presque Isle, Maine, in 1935*

Progeny	Number	Seedlings Showing Degrees of Late Blight Resistance								
		'O	N-	N	N+	G-	G	G+	Total	
		No.	No.	No.	No.	No.	No.	No.	No.	
182	No Blight X Ekishirazu	1	17	10	6					34
336	No Blight X Katahdin		4	8	15		4			31
3,730	Progeny of German races	3	1							4
3,738	" " " "	3	8	6	4					21
3,743	" " " "			2	1	1				4
3,744	" " " "	6	4		1					11
3,747	" " " "	2	2	1						5
3,868	" " " "		2	1	1					4
3,895	" " " "	3		4						7
3,897	" " " "	5	11	7						23
4,050	" " " "	1	5							6
4,054	" " " "		1							1
	Katahdin selfed		1	2	12	26	120	80	241	
	Green Mountain naturally fertilized				3	10	43	40	96	
	Green Mountain naturally fertilized				1	15	24	79	119	
618	S45349 X Ekishirazu ¹	28	56	201	157	46	14			502
627	No Blight X S45075 ¹			13	40	91	170	111	425	
663	Ackersegen X S45075 ¹			9	20	54	142	187	412	
672	Ackersegen X Katahdin ¹	3	11	42	64	99	114	130	463	
690	S45349 X Katahdin ¹	2	3	27	59	96	83	46	316	
699	S45349 X S45075 ¹			7	56	97	166	317	643	
	Katahdin check					2	22			24
	Green Mountain check					10	30	4	44	
	S45075 check						2	4	6	
	No Blight check		9	32	9					50
	Ekishirazu check		3							3
	Ackersegen check		2	1	2					5
	S45349 check		1	3						4

¹Single hills. Remaining lots and checks 10 hills to each lot.²See table 3 for description of classes.

found in the classes O to N+ in 1934 only five seedlings showed a greater infection than N+ in 1935 as shown in table 5. Four of these belonging to the No Blight X Katahdin progeny were classified as N+ in 1934 and the seedling from the German progenies in the G— class in 1935 was scored N+ in 1934. The close agreement for the two years indicates the reliability of even one year's results provided a satisfactory epidemic of the disease can be produced. In a progeny of Katahdin selfed, consisting of two hundred and forty-one seedlings, fifteen were found within the same range as No Blight, the other two hundred and twenty-six were in the Green Mountain range. Nearly all the Green Mountain seedlings were as heavily infected with blight as the Green Mountain variety itself.

In 1935, six progenies were grown in single hills, instead of ten hill rows as was done up to this time in the field tests, each hill representing a different segregate. By this method larger numbers may be tested and although more of them may escape than would be the case if ten hill plots of each were grown, a great number becomes infected and can be eliminated from further tests since they have definitely shown their susceptibility.

Number 618, one of the six new progenies which was tested in the field at Presque Isle in 1935, was from a cross of two resistant parents. Two others, 672 and 690, were from crosses between a resistant parent and Katahdin, the latter variety being susceptible but carrying probably two factors for resistance, both heterozygous, as shown by a naturally fertilized progeny and a selfed progeny. The other three progenies, 627, 663 and 699, were from crosses between a blight resistant variety and an early one, S45075, the latter being as susceptible to late blight as Green Mountain.

Approximately eighty-eight per cent of the seedlings of the cross between the two resistant varieties S45349 x Ekishirazu were found in the first four classes, O to N+. Crosses 672 and 690 gave twenty-six per cent and twenty-nine per cent respectively of the seedlings in these four classes. In the other three crosses, with S45075 as one of the parents, the percentages of seedlings in these classes are much lower.

Interpretation of these results can not be attempted before further tests are made of the apparently resistant seedlings and until other progenies have been grown and tested. The data are interesting, however, as they show how many of each progeny may be eliminated in the single plant stage on account of their susceptibility.

DISCUSSION

This work has been conducted for too short a time to permit definite conclusions but these preliminary studies have shown that there are different degrees of resistance and that resistance is definitely heritable. No immune types have been found, but from the economic standpoint a variety which would be satisfactory without spraying with bordeaux in a blight epidemic such as occurred in 1932 would be, all other things being equal, extremely valuable to the growers. One variety, a selection from the cross of Chippewa x Katahdin, was only slightly injured by late blight in the 1932 test. It has been tested for blight resistance and yield for four years. It has enough resistance so that it could be grown without spraying most years and would require fewer applications of spray material than Green Mountain in order to protect it in blight years. It has yielded an average of three hundred and seventy-four bushels of primes for four years as compared with an average of three hundred and forty-five for Green Mountain in the yield tests on Aroostook Farm. For three years it was grown in comparison with No Blight. It yielded an average of three hundred and fifty-five bushels of primes as compared with an average of two hundred and sixty for No Blight for three years. The average yield of Green Mountain for the same period was three hundred and forty-one bushels.

It would be desirable to know the nature of the resistance as found in so many of these seedlings but so far nothing has been done to determine it. From the economic standpoint, however, it is important to find varieties which escape the disease whether they be disease-tolerant, disease escaping because of their morphological characteristics or truly resistant because of some inherent quality of the protoplasm. That so many of the segregates of the so-called W-races are highly resistant at Presque Isle would indicate that the A forms of *P. infestans* are prevalent there since Müller found that all the W-races were susceptible to the S forms. Several of the segregates from the W-races were early and at the same time showed a high degree of resistance indicating that late maturity is not necessarily associated with resistance to late blight.

SUMMARY

The reductions in yields of potatoes in the United States caused by late blight are estimated at more than 9,000,000 bushels for a ten-year average (1926-1935). Varieties have been introduced into this

country which were comparatively blight-resistant but few of them had commercial value. The most promising of these, from the standpoint of the Maine potato growers, is No Blight, but this variety is not being widely grown.

Breeding for resistance to late blight was begun at a comparatively early date both in Europe and in the United States.

The work of K. O. Müller, Berlin-Dahlem, Germany, indicates that multiple factors are involved in the inheritance of late blight resistance. Physiological forms of *Phytophthora infestans* complicate the problem leading Müller to state that the only hope of a solution lies in the use of crosses between certain immune forms of *Solanum demissum* and cultivated varieties. Reddick, at Cornell University, is using crosses of this type in his attempts to solve the problem and is making real progress. Salaman, in England, has carried his crosses of *S. demissum* x *S. tuberosum* to the tenth generation with promising results. Schmidt in Germany, has not been able to maintain the immunity of the *S. demissum* after three successive back crosses to *S. tuberosum*. The work of the U. S. Department of Agriculture at Presque Isle, Maine; Beltsville, Maryland; and Oakland, Maryland; is an attempt to combine the resistance which has been found in some of the varieties of *S. tuberosum* with the most desirable characters of the best commercial varieties. It is believed that a high degree of resistance from the attacks of the physiological forms of *P. infestans*, which are prevalent at Presque Isle, Maine, at the present time, can be obtained without the use of species hybrids. Varieties resistant to late blight are being brought into the United States as fast as they can be found. These varieties and progenies of crosses between them and commercial types are being tested for resistance and other desirable characters.

Selections resistant to late blight have been obtained by selfing a susceptible variety, by crossing two resistant varieties, by crossing a resistant variety and a susceptible one which is probably carrying two factors for resistance, both heterozygous, and by crossing two susceptible varieties. Progenies related to the so-called W-races of Germany, sent to us by K. O. Müller, Berlin-Dählem, showed marked degrees of resistance.

If a heavy epidemic of the disease can be induced the results of one year's test seem quite reliable, since it was found that the apparently resistant seedlings under such conditions were in the same classes the following year as compared with the checks, No Blight and Green Mountain.

One variety, a selection of a cross between two susceptible varieties, was only slightly injured by the blight epidemic of 1932 in a plot not sprayed with Bordeaux mixture throughout the growing season. The checks in the same plot were killed by blight. For four years it has been as resistant as No Blight in the various blight tests and more resistant than Green Mountain. It has outyielded No Blight by ninety-five bushels per acre of primes for a three-year average but Green Mountain by only fourteen bushels for the same period. Fourteen bushels is not a significant difference if twice the standard error of a difference is used as the criterion. This variety will be given extensive tests with growers as soon as the seed stock can be increased sufficiently.

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INFLUENCE OF FERTILIZER ON POTATO MATURITY AND TYPE

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Commercial fertilizers have had a very definite influence under Montana conditions upon such factors as potato maturity and type. In many districts maturity is a problem, as field frost is a factor that must be considered any time after October 1st.

In order to analyze results from a fertilizer test, something must be known about soils and other conditions. Soils in Montana are showing a phosphorus deficiency in many areas; there appears to be an ample supply of potassium but nitrogen is variable in amount. By varying the fertilizer treatment, it has therefore been possible,

under outdoor conditions, to arrange fertilizer tests so that we have a range in the amounts of phosphorus and nitrogen, varying from very low to very high. With potassium fairly plentiful, we have not had low potassium conditions with which to work.

Early maturity is important in our northern climate. This has been measured by skin set and amount of loss of skin under normal handling. A short statement of results follows:

1. Use of nitrogen alone has delayed maturity, which generally means much skin slipping at the time the potatoes must be dug.

2. Increasing the potassium content of the soil resulted in delayed maturity and an immature crop at harvest time—even slower maturity than followed the use of nitrogen.

3. Phosphorus distinctly improved maturity. At harvest time the skin had set better than under any other combination of conditions.

4. The poorest maturity resulted when potassium and nitrogen were used in combination.

5. With nitrogen and phosphorus in combination, good maturity was obtained, where the nitrogen in the soil was not too abundant in relation to the phosphorus.

Phosphorus has been a very distinct factor in improving maturity in Montana, resulting in somewhat earlier harvesting and reducing danger from field frost. When used with nitrogen, the results have also included increases in yield.

Fertilizers have affected the type of potatoes in several directions. The Russet Burbank potatoes show extreme variation in the character of the netting under different field and fertilizer conditions. In some instances the netting has been almost lacking and questions have been raised concerning whether or not poorly netted samples were Russet Burbank.

Where phosphorus was low, the netting was not prominent. Phosphorus, when added to soils of this type, resulted in a distinct netting. By increasing the nitrogen content of the soil very poor netting resulted, and by adding potassium netting was almost eliminated. The poorest netting of all followed the use of nitrogen and potassium. Good results as to netting were obtained with nitrogen and phosphorus in combination, but netting was reduced when potassium was added to the nitrogen and phosphorus combination. Phosphorus seems to be a distinct factor in the production of well-netted tubers, while potassium eliminates or reduces the netting to a great extent.

A second type factor deals with the grade of potatoes as influenced by smoothness and pointed ends. It has been measured in terms of grade without, at the same time, considering the maturity factor. Under Montana conditions, the addition of a nitrogenous fertilizer has resulted in a lower percentage of the tubers making No. 1 grade and a material increase in percentage in the No. 2 grade, whereas there was little change in the percentage of culls. The addition of phosphorus has resulted in a distinct gain in the percentage of tubers falling in the No. 1 grade. It was interesting to note also, that with the use of phosphorus, a very pronounced gain was made in the set of tubers to the hill. In this case potassium had an influence similar to that of phosphorus, regarding the improving of the shape of the tuber.

The percentage of tubers falling into No. 1 grade does not give a complete picture of the differences obtained. Where phosphorus was used, alone or in combination with nitrogen, the No. 1 grade was distinctly better than where nitrogen alone was used, as the potatoes were smoother and truer to type. With the nitrogen fertilizer particularly the general appearance of many tubers included in the No. 1 grade was not equal to the tubers from the phosphorus plots, where they more closely approached the desirable Russet Burbank type.

Increases in total yields have also been pronounced from the use of phosphorus. The percentage of gain, however, in the No. 1 group distinctly exceeds the percentage of gain in the total yield. In many cases the total gain made practically belonged to the No. 1 group. For maximum results in Montana, nitrogen and phosphorus must be used together.

The measurements made on the relative dimensions of the tubers show that potassium produced the shortest tuber as contrasted with the breadth. Nitrogen gave us the longest tuber, and phosphorus produced tubers that might be classified in an intermediate group.

Therefore, under Montana conditions, we may improve the potato crop by building up the nitrogen by the use of sulphate of ammonia, and by rotations with alfalfa. Phosphorus also is important. The use of phosphorus in the growing of Russet Burbank potatoes results in earlier maturity, improved handling qualities, better netting, and an increase in percentage of better shaped tubers, resulting in heavier yields of No. 1 potatoes.

INOCULATION OF POTATO SEEDLINGS WITH THE YELLOW DWARF VIRUS

E. J. WHEELER

Michigan State College, East Lansing, Michigan

The potato yellow dwarf epidemic that was prevalent in the potato fields of Michigan in 1931-1932 suggested the need for a comprehensive breeding program to obtain a variety resistant to yellow dwarf. All the commercial varieties grown in Michigan showed a high percentage of the disease. The work of obtaining a resistant variety was conducted with a number of promising seedlings that were obtained from the U. S. D. A., also, others produced at the Michigan State College Experiment Station.

Many of these seedlings had been grown at the Lake City Potato Experimental Station, Lake City. The disease was very severe in this section and approximately fifty per cent of these seedlings were eliminated in the field by yellow dwarf during the summer and fall of 1932.

Promising seedlings that had characteristics desired in a commercial variety were saved for increase the next year and thirty-seven of these were included in the yellow dwarf inoculation experiment.

Diseased tubers containing yellow dwarf were used in the plug grafts. Six-ounce tubers of the potato seedling to be grafted were cut in half. One half of the seedling tuber was planted without treatment and used as a check for the yellow dwarf plug-grafted half. Two cork borers were used, one $\frac{3}{8}$ inch in diameter and the other $\frac{1}{2}$ inch. The $\frac{3}{8}$ inch size was used to remove a plug from the seedling and the $\frac{1}{2}$ inch for removing a plug from the diseased tuber. In the core opening of the seedling the plug from the diseased tuber was inserted. The larger sized core made a very close union between the diseased tuber plug and the seedling tuber. Paro-wax was used to seal the ends of the plug.

In the winter of 1933-'34 a plug grafting experiment was conducted in a greenhouse which was held at a temperature of 27°C . Ten tubers from each of thirty-seven seedlings were cut in halves. One half of each seedling was plug-grafted, and planted between its uninoculated half, and the diseased tuber from which the plug was taken. The tubers were planted on January 3, 1934 in six-inch pots

in the greenhouse. At the end of two weeks notes were made on the presence of yellow dwarf. On February 12 the plants were approximately six inches high. With only a few exceptions, most of the yellow dwarf had appeared by February 12. The seedlings were harvested on March 30 and the tubers were planted in the field in June.

The results presented in table 1 indicate that some seedlings were susceptible, whereas others were resistant to yellow dwarf, even though they had been subjected to a severely infested field.

None of the seedlings that were healthy in the greenhouse contracted the disease in the field, whereas, all the tubers from the plug-grafted seedlings that showed yellow symptoms of dwarf in the greenhouse, showed yellow dwarf in the field.

TABLE 1.—*Transmission of Yellow Dwarf by plug grafting*

(Greenhouse 1934)

	Plug Grafted Seedlings	Healthy Half of Plug Grafted Seedlings
Total number of seedlings	37	37
Number of seedlings showing yellow dwarf.....	18	0

In 1935 the yellow dwarf experiment was continued at the Lake City Potato Experiment Station. From four to twelve tubers of each of the one hundred and forty-four seedlings were plug-grafted. Seedlings included in this experiment were secured from the better seedlings of the potato breeding plot. Nine of the thirty-seven seedlings from the 1934 experiment were included in the 1935 test. Seven of the seedlings, free from yellow dwarf in 1934, were again free in the 1935 test, whereas two seedlings showing symptoms of yellow dwarf as a result of the plug grafting in 1934 were susceptible in the 1935 test.

The yellow dwarf diseased material in the 1935 experiment was obtained near Traverse City from a farmer whose field carried ninety per cent of the disease.

Large tubers were planted and only twenty-five per cent of them revealed the disease.

TABLE 2.—*Transmission of Yellow Dwarf in plug grafting*
(Field 1935)

Diseased Tubers from Which Plug Was Taken	Whole Plug Grafted Half	Seedling Tubers Half Not Plug Grafted
Total number of plants	1111	1111
Number plants showing yellow dwarf	274	27
		5

DISCUSSION

Table No. 2 gives a summary of the 1935 field transmission of yellow dwarf in plug-grafted tubers. There were five plants in the non-plug-grafted series that showed yellow dwarf. The corresponding plug-grafted seedlings had yellow dwarf, although the diseased tubers from which the plug was taken did not show any symptoms of yellow dwarf. Only twenty-five per cent of the diseased material used for plug grafting contained yellow dwarf. A higher percentage of yellow dwarf would have been more desirable.

Field results in 1935 were not so conclusive as were the green-house tests of 1934. However, all seedlings that showed resistance to yellow dwarf in 1934 were also resistant in 1935, likewise seedlings susceptible to yellow dwarf showed yellow dwarf symptoms in both years.

CONCLUSION

Plug-grafting is effective in field or green house for transmission of yellow dwarf.

Parent breeding stock may be tested for yellow dwarf resistance.

Several seedlings have failed to show the disease either from exposure to heavy field infection or from plug-grafting.

Possibly the plug-grafting method may be used in obtaining a yellow dwarf resistant variety.

SECTIONAL NOTES

CALIFORNIA

The crop in the Stockton, California District, is growing normally. The early planted crop produced normally but there is evidence that the later crop will not do so well. The yields will probably average

about the same as last year, but the reduction in acreage will decrease the total production.

The State of California is now using Stockton potatoes exclusively. There is a wide demand for these potatoes throughout the United States and if this demand continues, it will take many potatoes out of the state that are ordinarily used at home.

In the Klamath Falls District, which includes land both in California and Oregon, the crop as a whole looks almost perfect. The plants in these fields have entirely recovered from the effects of two early frosts and every evidence is at hand for a bumper crop. (Aug. 7).—H. G. ZUCKERMAN.

COLORADO

Conditions throughout the state continued subnormal during July, with practically no rainfall and excessively high temperatures. Irrigation water supplies were exhausted in the San Luis Valley about the first of July, and by abandoning other crops, growers were barely managing to keep the potato vines alive with water pumped from wells. However, a three-day rain about the first of August supplied enough moisture for good growth and at present growers should be able to supply enough water from the wells to produce a crop, only slightly below normal for the district.

The crop in the dry land section of eastern Colorado is nearly a total failure, because of jackrabbits, Colorado potato beetles, heat and drought.

Stands in the mountain districts, on the western slope and at Greeley are below normal because of the dry, cloddy condition of the seed beds at planting time, and the lack of the usual rains and snows during May.

The Rhizoctonia damage is especially severe in the mountain districts this year. Considerable damage is beginning to show from Fusarium Wilt in eastern Colorado, and at the lower altitudes on the western slope.

The early crop in the Fruita district amounted to approximately two hundred and sixty cars and is practically harvested. Delta and Montrose counties are moving Cobblers and Triumphs, as is also the Greeley district. By August 20th, Triumphs should move from the San Luis Valley.

Prices have been very satisfactory, and growers have received from \$1.75 to \$2.75 per 100 for the crop. One grower in the Fort Lupton

district near Denver dug one hundred and eighty sacks of Cobblers from each acre and received \$2.75 per 100.

The acreage of certified seed entered this year is 1,968 as compared with more than 3,000 acres last year. Rejections on first inspection have been far below what they were last year and it now looks as though the total crop certified will be as large, if not slightly larger, than that of last year. (Aug. 12).—C. H. METZGER.

CONNECTICUT

During the past month, Connecticut, as a whole, has received insufficient rainfall for the majority of the crops, including potatoes, and as the previous month was also dry, undoubtedly the potential yields have been reduced considerably. Last week, however, the main potato-growing sections received enough precipitation to remove any threat of serious losses. (Aug. 11).—B. A. BROWN.

INDIANA

Today we are getting our first good rain since approximately the first day of May. This should be a boom to the late crop of potatoes. A number of growers in the northern part of the state, where they have good water supply, are putting in irrigation which will possibly boost their yields from 100 to 150 bushels to the acre since there is a good vine growth and a fair set. During the past month potatoes dropped fifteen points from the usual normal production to approximately thirty-nine per cent of a normal crop this year; this is about forty-one points below the 10-year average. We anticipate an average yield, between 50 and 65 bushels which is a very, very light crop for us.—(Aug. 14).—W. B. WARD.

MAINE

The August crop report has brought cheer to the potato growers in Maine. Conditions are now favorable, and indicate that we shall have average crops of good quality. Blight has been controlled by intensive spraying which, with the aid of favorable weather, would indicate that no appreciable damage will be done to the crop. A return of rainy weather or neglect on the part of growers to follow the spray schedule might cause havoc.

The acreage passing first inspection, for certification, totaled 19,312 against total acreage certified last season of 20,165. Without

question there will be still further reductions on completion of the second inspection which will make the reduction from last year even more marked. A larger part of the reduction to date has occurred in the Irish Cobbler variety. With prospects of a good fall market facing us, Certified Cobblers should sell on a better comparative basis this coming season than has been true for some time.

Some potatoes have already been shipped. It is doubtful if much of the crop will be moved before the last week in August. By the first of September harvesting will begin in earnest.

It has been a great disappointment to many people vitally interested in the permanent improvement of the potato deal, to learn that the Aroostook Production Credit Association has largely abandoned its marketing program. Some features such as warehousing and partial control of security are being continued. We are hopeful that out of this something permanently beneficial will develop. It is regrettable that such a radical change is made now.

The results of the marketing pool for last year were satisfactory to most growers. An average price of \$1.31 per barrel for 165 lbs. was secured, after all charges had been deducted. Expenses were kept at a minimum; the management was kept at a very low cost; sales were handled in an orderly way; all of which helped the entire potato deal tremendously. With much better price prospects facing us, it was decided to discontinue the marketing program for this coming season. (Aug. 17).—FRANK W. HUSSEY.

MASSACHUSETTS

Local showers, more abundant in some sections of the state than others, have helped the potato crop and at the present writing, indications point to a satisfactory crop. Limited digging of Cobblers is already in progress. Green Mountains are in somewhat better condition than they were at the same time a year ago, and give promise of satisfactory yields. Aphids have been the predominant pest during the dry periods of the past month and more nicotine than usual has been used by growers. Leafhopper infestation appears to have been somewhat lighter during July than normally, but the amount is more pronounced with the approach of August.

Growers regard the market situation as very favorable and seem little disposed to hasten the marketing of their crop. There is some indication that a larger proportion of the crop than usual may be stored in anticipation of favorable markets later. (Aug. 1).—R. W. DONALDSON.

MONTANA

The acreage entered for certification this year is slightly larger than that of last year. It is doubtful, however, whether the yield will be so great as that of last year because of the exceptionally dry, hot weather and the increase of pests. Some of our small acreages have been seriously damaged by grasshoppers, blister beetles, and false chinch bugs. Some fields show exceptionally good stands whereas in others the set is up rather light on account of the extreme heat coupled with poor cultural practices. (Aug. 8).—E. E. ISAAC.

NEBRASKA

The situation in Nebraska has declined continually since the first of July. With the exception of one small area, comprising about two counties, where potatoes are a minor crop, we have had no rainfall since planting began. The plants in the fields which survived blister beetles and grasshoppers, as well as the attacks of rabbits, have burned to the ground by this time.

Most fields have had absolutely no cultivation except the use of the harrow. Growers are reluctant to put any more expense into their crop, and for that matter, the lack of weed growth makes cultivation unnecessary.

Our only relief has been an abatement of the high temperatures experienced during the latter part of June, and the month of July. This lowering of temperatures, combined with cool nights, has revived some fields, even though no moisture fell. Another increase in temperature has been experienced during the past four or five days, and the fields have reflected the results almost immediately.

No relief is promised for several days and we feel now that our crop will be similar to 1934, when two hundred cars of certified seed were shipped, whereas the normal production should be eight hundred to one thousand.

In all probability, the certified growers as compared to non-certified, have somewhat the better of the situation, because of better cared-for fields. Our acreage for certification was about the same as last year, when we had ten thousand acres, principally of Bliss Triumphs. Perhaps twenty per cent of this acreage has already been dropped or withdrawn from certification, because of the unfavorable conditions. We anticipate a greater withdrawal, if rain does not come soon. (Aug. 13).—MARX KOEHNKE.

NEW JERSEY

At the present time the market is dull and the dealers are maintaining a price of \$1.85 a hundred pounds to the grower. The dealers have closed their loading stations for several days. This followed very heavy loading on Thursday of last week. Although there is no Central Sales Office this year the dealers have done all within their power to prevent over-loading and unnecessary price reductions. All who have followed the marketing of the New Jersey crop this season have agreed that without the excellent cooperation on the part of the dealers it would have been impossible to maintain the price as it has been for the past several weeks. The crop is smaller than that of last year, but the prevailing price enables the growers to show a satisfactory profit. It is estimated that half the crop is harvested and in some quarters the opinion is held that the movement will be slower for the remainder of the season since some growers anticipate higher prices. (Aug. 17).—WILLIAM H. MARTIN.

NEW YORK

The most significant feature of the potato situation in New York at the present time is the severe drought which covers all the western and central portions of the state. The earlier plantings in this area will be severely reduced on account of the dry weather. Late-planted potatoes may have a better chance if rain comes soon, but the stands are poor, and potatoes planted the middle of June have grown slowly and are not more than half the usual size. Long Island has had enough rain in recent weeks, but the crop will be affected by the early drought and by a heavy infestation of aphids. Northern potato sections have had an abundance of rain. Dry weather has made potato inspection work difficult. Fortunately, all indications are that the seed planted for certification was freer from virus diseases this year than ever before. Yellow dwarf has almost disappeared.

The statistics on potato inspection work are given in the table below. (Aug. 5).—K. H. FERNOW.

Variety	ACRES		
	Entered 1936	Entered 1935	Passed 1935
Cobbler	508	500	445
Green Mountain	422	440	395
Smooth Rural	393	562	346
Russet Rural	316	482	305
Others	154	141	55
Total	1893	2215	1546

The record high temperatures throughout most of New York with the exception of Franklin and Clinton counties seriously affected yield prospects during July. Northern New York is the only area where growing conditions have been favorable. A rainy period which prevailed from August 5 to 12, will save the crop, especially the plants which were not already nearly dead.

On Long Island, Cobblers are producing a fair crop; the present price to growers being about \$1.70 cwt.; seconds, 60 cents per cwt. The Green Mountain crop will make only a little more growth as the *aphis* infestation is very bad, and consequently the yields will be seriously reduced. No Green Mountains are being dug. Growers have the feeling that prices will improve.

The smallest crop since 1925 will be harvested in New York, the most serious reduction being in Steuben, Allegany, Erie, Monroe, Genesee, Wyoming, Livingston, Wayne, Onandago, and Ontario, all of which are important potato-growing counties. Central New York, east of Syracuse, has had more rain and conditions are more nearly normal. No blight has, as yet, been reported in the state.

Over seven thousand growers attended the Empire State Potato Field Day at Hermitage on August 6th. About \$100,000 worth of potato machinery was exhibited and the dusting of potatoes by aeroplane was featured. On August 12th about eight hundred attended the northern New York potato rally on the farm of E. G. S. Gagnier at Cherubusco. (Aug. 14).—E. V. HARDENBURG.

NORTH CAROLINA

The Irish potato crop in the mountain section of this state was severely injured by drought. Much of the certified seed acreage was abandoned before the second field inspection. Last year one hundred and eighty-one acres passed certification. This year we have only twenty-seven acres of certified Irish potatoes. (Aug. 11).—ROBERT SCHMIDT.

NORTH DAKOTA

North Dakota is experiencing a very dry summer, and for a period of ten days during early July, it underwent a heat wave in which the high point each day ranged from 100 to 115 degrees F. Since the middle of July, however, some rain has fallen in nearly all sections of the state where the commercial potato acreage is grown.

The western part of the state is suffering most heavily, because of heat and drought, and probably not over one-third of the crop can be expected. In the eastern part of the state more rain and cooler weather has prevailed, and we are looking for at least half a crop. If additional heavy rains should fall during the middle of August, we should expect to get more potatoes than the above estimate.

This year we have 13,329 acres entered for certification. This is slightly over 1,000 acres more than was entered a year ago. This increase is due to a larger acreage of Irish Cobblers this year. Our Bliss Triumph acreage is increased but very slightly, whereas the Early Ohio acreage has dropped off slightly.

The total production of certified potatoes will be much smaller this year than last year because of the drought. The tubers will not be large in size but will be clean. Except for virus diseases, there should be practically no disease developing such as Rhizoctonia, scab, etc. (Aug. 10).—E. M. GILLIG.

OHIO

In the northern part of the state the Cobbler potatoes are now being dug. The better crops are yielding two hundred to two hundred and fifty bushels to the acre. The southwestern portion of Ohio still continues dry. Crops that have not been dug are showing sprouts on the tubers. Where the tops have remained green, there is some second growth.

During the past two weeks the weather in northern Ohio has been more favorable for the late crop. Late planting and the hot dry weather have delayed setting. If we have a favorable fall and late frosts, we should have a good crop of late potatoes.

There are forty acres of Rural Russet potatoes entered for certification. Last year twenty-five acres were entered. The crops look unusually good at the present time. (Aug. 15).—E. B. TUSSING.

OREGON

The certified seed acreage has fallen off slightly because of the decrease in demand from California for Burbank potatoes. In the last few years the White Rose variety has eclipsed the Burbank, as the former are dug in the summer and the market at this time has been better than the later winter market for Burbanks.

Accordingly, the California trade is demanding White Rose seed which is more difficult to grow than the Burbanks. Our certified seed acreage will likely be about fifteen per cent less than in recent years. We are having difficulty in producing high quality White Rose certified seed. Tuber unit planting, greenhouse indexing and so forth seems to be of no avail. The variety is so attractive to insects because of its soft foliage that one per cent of virus may easily spread to fifteen or twenty per cent by the end of the season.

Our Klamath district will probably have the largest Netted Gem crop on record; 5,000 cars were shipped in 1934 and this will probably be exceeded this year. Yields are fine and quality will be wonderful barring some catastrophe such as a severe freeze.

Many of the early Triumphs from southeastern Oregon (the Snake river area) were washed this season and this washed stock commanded, in general, a premium of about fifteen cents per hundred.

The compulsory grading law which has existed in this state for several years has met the approval of the growers. (Aug. 11).—E. R. JACKMAN.

RHODE ISLAND

Some Cobblers have been harvested and are selling at approximately \$1.90 a hundred on the farm. The yields vary considerably—from two hundred to four hundred bushels to the acre. The dry weather in June and latter part of July reduced the crop on the lighter soils.

We had one of the worst years on record for aphids. There is no question about the value of thorough spraying. Where this practice was neglected, the crop suffered severely.

The Green Mountains generally are in good condition except where the aphids were not controlled.

Some early blight is prevalent in certain areas. (Aug. 13).—T. E. ODLAND.

SOUTH DAKOTA

One field of potatoes has been entered for certification in Custer County, South Dakota, and one in Shannon County. All others are in the eastern part of the state. We have 270½ acres

entered for certification in the state as compared with 343 1/6 acres last year.

' Early potatoes have been greatly damaged if not ruined by drought and insects. Late plantings have a chance with immediate rain but the present prospects are for little or no crop. (Aug. 11).—S. P. SWENSON.

CANADA

A total of 19,400 acres of potatoes was entered for inspection with a view to certification in 1936, as compared with 20,374 acres entered in 1935. By varieties the acreage entered is as follows: Irish Cobbler, 9,067; Green Mountain, 6,512; Bliss Triumph, 1,664; Rurals, 893; Netted Gem, 316; Early Ohio 246; Katahdin, 245; Warba, 82; President, 35; Chippewa, 9; Other varieties, 331.

There is every prospect of a good crop in the Eastern Maritime Provinces, Quebec and in British Columbia. Planting was somewhat delayed in the Eastern districts, but the growing conditions have been very good during July and August. Throughout Central Canada the crop yield will be below average because of drought conditions. Prospects are good for fair prices and there is a large demand for certified seed again this season. (Aug. 14).—JOHN TUCKER.

THE PRICE SITUATION

The following report on potatoes was released on August 15 by the Bureau of Agricultural Economics of the United States Department of Agriculture: With the late potato crop deteriorating sharply during July, and with demand conditions improved over those of last year, the prospects are for potato prices to average much higher this season than they have for any season since 1925-26. Crop conditions as of August 1 indicate a late potato crop about as small as the extremely short crops of 1925 and 1919. In those years, when the price level was considerably higher than in this year, farm prices of potatoes averaged \$1.66 and \$1.91 per bushel, respectively. Based upon crop conditions as of August 1, the 1936-37 United States farm price is expected to average at least twice as high as for the 1935-36 season when it was about 70 cents per bushel, and perhaps three times the average farm price of 47 cents for the 1934-35 season. In the pres-

ent season, as was the case in 1925-26 and 1919-20, potato prices are expected to decline to a seasonal low point in September or October, and then advance rather sharply to the next April.

Potato crop prospects declined sharply during July, and on August 1 production in the 30 late states was indicated to be only 244,253,000 bushels. This is 20,000,000 bushels below the July 1 forecast for these states; 75,000,000 bushels below the crop harvested in 1935, and is the smallest crop of late potatoes since 1919. For the United States as a whole the potato crop is indicated to be 294,537,000 bushels, or about 93,000,000 smaller than the 1935 crop and nearly 80,000,000 bushels below the 1928-32 average production. With the crop in the early and intermediate states also curtailed by drought, the total United States crop of potatoes will be nearly 3,000,000 bushels under the small crop of 1919 and the smallest since 1916.

The indicated production in the three Eastern surplus late states is 86,200,000 bushels (the same as forecasted in July), or about 6,000,000 less than in 1935 and 10,000,000 less than the 1928-32 average. In the five central surplus late-potato states the crop is indicated to be 52,945,000 bushels, or 45,000,000 bushels (46 per cent) below the 1935 crop in these states and nearly 37,000,000 below their average production for 1928-32. The crop in the 10 Western surplus late states is forecast at 71,798,000 bushels, which would be 11,000,000 bushels less than in 1935 but about equal to their average production. Potato production in the 12 other late states is indicated at 33,310,000 bushels this year, or 13,000,000 below the crop of 1935.

Market prices of potatoes have shown a seasonal decline since early July. The general level for Cobblers in the Chicago car-lot market during early August was \$2.50 per 100-pound sack, with Idaho Russet Burbanks as high as \$3.00. This is slightly below the price range of a month ago, but compares with \$1.12 for Cobblers and \$2.00 for Idaho potatoes a year ago. The New York wholesale market recently reported Long Island and New Jersey Cobblers around \$2.00 per 100-pound sack, compared with \$2.55 in early July and about 77 cents at this time last year. The f.o.b. price at New Jersey shipping points had declined slightly to about \$1.95 during early August, and against 70 cents a year ago. Shippers on Long Island were receiving about \$1.90 per 100 pounds, whereas at this time in 1935 the f.o.b. price was scarcely half that amount. The active season on the Eastern Shore of Maryland and Virginia closed with the best stock returning shippers around \$2.00 per 100-pound sack, compared with \$2.43 in early July and only 62 cents in early August of 1935.

On July 15 the United States average farm price of potatoes had reached the relatively high level of \$1.41 per bushel, as against \$1.37 at the middle of June, 52 cents a year ago, and an average of 81½ cents per bushel for July of 1910-1914.

Shipments of potatoes by rail and both during the week ended August 8 totaled 3,415 cars, of which New Jersey furnished nearly half. Other active shipping states in the order of their importance were Idaho, California, Colorado, Washington, New York, Pennsylvania, and Utah. The week's movement was almost 60 per cent heavier than that of the corresponding period last year. The season total to August 8 was about 51,120 cars, compared with 48,370 cars to the same time last season.

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THE ANNUAL MEETING

The annual meeting of the Potato Association of America will be held at Atlantic City from Tuesday, December 29, to Thursday, December 31. The Ritz-Carlton has been designated as the official hotel for the Association and also for the American Society of Agronomy. Haddon Hall will serve as headquarters for the American Society for Horticultural Science and the A. A. A. S. general headquarters. The Hotel Ambassador will be the headquarters for the American Phytopathological Society. These three hotels are on the boardwalk, and the rates are approximately the same for each. The various groups will meet in Convention Hall, also situated on the boardwalk.

Joint sessions have been arranged with the American Society for Horticultural Science on Tuesday afternoon, December 29; and with the American Phytopathological Society on Thursday afternoon, December 31. In addition, it is planned to arrange for a session on potato breeding. It will be recalled that some very interesting papers were presented on this question last year, and Dr. F. J. Stevenson has again agreed to arrange for a series of papers summarizing the year's activities in this extremely important field of research. Another session is being arranged to discuss soil fertility problems. The committees on nomenclature, potato consumption, certification, culture and storage, fertilizer investigations, virus diseases and insects will likewise report. In this way it is hoped to summarize the investigations connected with the potato industry for the past year.

Titles for papers to be presented at the annual meeting should be submitted to William H. Martin in the near future. This is important, as the program must be completed by the latter part of October. Papers presented at the Atlantic City meeting will appear in the *American Potato Journal* next year. This, the 23rd Annual Meeting of the Potato Association, promises to be a most interesting one, since a real opportunity will be afforded to discuss the many problems of the potato industry.